

WASHINGTON

SCIENCE TRENDS

HIGHLIGHTS

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* WELDED ELECTRONIC CIRCUITS

Space Technology Laboratories Inc. has reported to the Air Force that welded electronic circuit techniques possess many advantages for applications in missiles and space vehicles, high speed computers and office equipment and industrial control systems, as well as other areas. Such circuits, it is reported, offer potential solutions to such problems as size reduction, reliability, weight reduction and manufacturability.

♢ Background: STL points out that although welding techniques have been used for more than 20 years in electron tube fabrication, the basic idea of welding electronic part leads appears to have originated as late as 1954 -- in a Hughes Aircraft Co. project. With further development, the technique is being employed by such ballistic missile contractors as International Business Machines and AC Spark Plug.

♢ Advantages: Here are some of the specific advantages seen in welded circuits:

✓ Long part leads, circuit boards, terminals, clips and other hardware can be eliminated -- resulting in a packaging density much higher than that possible with conventional methods. In general, welding provides a 50 percent size reduction over "sophisticated" printed circuit boards, and an attendant weight reduction.

✓ Connections can be made close to heat-sensitive components. This eliminates possible damage to solid-state devices sensitive to high temperature, since the heat required to make a weld is concentrated in an extremely small area for a very short time. In addition, the temperature gradient along the part lead is very steep.

✓ Conductors are homogeneously fused. The metal of the conductors joined in a welded junction is fused so that no interface of a joining metal is present. This produces joints better able to withstand severe shock and vibration environments.

✓ Welded junctions have higher mechanical strength. STL says that in tensile-shear and flexing tests, welded junctions are superior to soldered junctions. Raytheon Manufacturing Company has found that flexing tests show an advantage for welded junctions as high as 15 to 1. In addition, such junctions are more uniform in strength characteristics.

✓ Welding process is highly controllable. Many disadvantages of soldering (such as the use of fluxes and preheating) are eliminated. Many of the operator variables can be avoided, as well.

✓ Welding technique is probably faster and less costly. In tests at Massachusetts Institute of Technology, two technicians assembled a welded module as fast as six technicians assembled the same circuit on printed circuit boards. (Continued)

* WELDED ELECTRONIC CIRCUITS (Continued)

✓ Welded junctions can withstand higher temperatures than solder. It isn't done often, but circuits to be used at high operating temperatures can be welded since junction strength is maintained almost to the softening temperature of the metal leads. (In comparison, use of solder is limited above 160° C.)

✓ Welded circuits can be constructed for rugged use. Some of the reasons are outlined above. In addition, high component density creates a unit mass that is nonresonant and structurally rigid. Even without encapsulation material an assembly has a high degree of rigidity, since stiff metal ribbon is used for interconnecting component leads.

✓ Other advantages. Design flexibility is said to be excellent. Shape of the module can be arranged to fit unique packaging configurations. Proper encapsulating materials can aid in dissipating heat generated during circuit operation. Encapsulated modules are tamper-proof and replaceable in case of malfunction. Field repair is practical, due to simplicity and portability of welding equipment.

∅ Six basic steps are involved in making a typical welded electronic circuit module:

✓ The electronic parts are placed in a compact cluster with the part leads inserted through holes in plastic end wafers. The wafers are closed together, with sufficient space to accommodate the longest part.

✓ Interconnections between part leads are made by welding with fine wire or ribbon.

✓ Preliminary electrical tests are made of the circuit.

✓ The entire unit is normally given a conformal plastic coating to hold the parts in place for ease of handling and to prevent damage.

✓ The spacers are then removed, excess plastic trimmed, and excess part leads and wires clipped.

✓ The module may then be encapsulated in plastic material.

∅ Refinements in this basic concept include:

✓ Use of plastic end wafers with photographic film welding patterns.

✓ Use of welded wire matrices in the plastic end wafers.

✓ Use of multilayer interconnecting wire matrices for module mounting.

✓ Use of metallic heat-conductors embedded in the modules.

(Report of 59 pages detailing process control, packaging design considerations, fabrication methods and practice and metallurgical evaluation now available through military channels or at \$6.60 through OTS, U. S. Department of Commerce, Washington 25, D. C. Ask for Report STL/TR-60-0000-09178)

* HIGH SPEED CAMERA REQUIREMENT

The Navy is interested in the development of a high speed camera (with a maximum frame rate of 4,000,000 to 400,000,000 frames per second) that is compact, reliable, rugged and easily synchronized. The camera would fill the present-day gap between smaller, moderately-priced rotating prism moving-film cameras and the bulky, expensive, rotating-mirror fixed film cameras. Such a camera could be used in much the same way as the rotating-prism camera, but for events occurring at much greater speeds; in the study of chemical explosions, high speed jets, etc. The camera should possess an exposure time of one-tenth of a microsecond or less, and a capacity of 100 or more frames per event.

* AEC ALTERS COST PRINCIPLES

Atomic Energy Commission is changing its policies governing the reimbursement of Commission contractors. The regulations provide:

- ✓ Costs of preparing bids or proposals -- successful or unsuccessful -- properly chargeable to the division, plant or other unit at which contract work is being performed will be allowable if the subject matter is applicable to the AEC program. However, such charges must not exceed one percent of the direct material and labor costs for the contract work.
- ✓ Incentive compensation will be allowable -- provided total compensation paid to any individual is "reasonable for the service rendered" and does not exceed costs allowed by the Internal Revenue Service for tax purposes.
- ✓ Compensation for personal services must be in line with that paid under the contractor's established policy. Compensation must also conform generally with that paid by other firms of the same size in the same industry.
- ✓ Bonus and incentive compensation paid to employees other than those whose pay is directly reimbursed will not be allowed in construction and operating contracts, where home and general administrative expense is not allowable.

* HOUSE COMMITTEE BOOSTS INFLATABLE STRUCTURES

The House Committee on Science and Astronautics has reported that "no fundamental breakthroughs" are required before expandable and inflatable structures can be used in space flight. At the same time, the Congressional group has urged greater attention to the potentials of such structures. The Committee reports:

- ✓ The work which has been done shows much promise, limited only by the ingenuity of engineers to think up more possibilities.
- ✓ Applications already identified include passive communication satellites, manned space stations; reentry glide vehicles of low wing loading (hence exposed to lower temperature peaks) and able to land at more airfields; aids to ballistic reentry including drag brakes, Ballutes and landing bags; solar collectors, communication dishes and radar reflectors of desired shape and rigidity; telescopes and other uses requiring precise control of ultimate size and shape.
- ✓ Inflatable and expandable structures, the Committee states, suggest the opportunity to undertake some missions in space sooner than would otherwise be the case because smaller launch vehicles ready earlier than larger launch vehicles will be able to put into orbit these lightweight structures.
- ✓ In addition to any time-saving factor, expandable structures will be able to make other contributions when used properly. These are said to include:
 - Savings in weight, hence increasing total useful payload.
 - Easier passage through the atmosphere to orbit, with fewer aerodynamic problems than a large, already erected structure would entail.
 - In general, more reliable unfolding of the packaged structure to correct final shape than with already rigid, hinged and telescoping structures.
 - A pressurized lightweight structure can withstand strong forces including temporary overloads without the permanent collapse normal rigid structures usually face when a overload seriously deforms them. Therefore, although weight can be saved by building expandable structures designed to be only as strong as weightless free fall requires, such structures need not sacrifice strength, where needed.

TECHNICAL TRENDS

- The Federal Communications Commission, Information Office, Washington 25, D. C. has available Bulletin 16-B, outlining rules and other information on educational television. ✓✓✓ The Interior Department is renewing its invitation to American Industry to take part in the helium purchase program. Details are available from the Office of the Assistant Director - Helium, Bureau of Mines, Room 4625 Interior Building, Washington 25, D. C. ✓✓✓ The Post Office Department, Office of Research and Engineering, Washington 25, D. C. has signed research contracts with the National Cash Register Co. and Stanford Research Institute, for development of techniques through which luminescent and magnetic materials could be used for the "tagging" of postal indicia. ✓✓✓ The Lincoln Laboratory, MIT, has designed for the Defense Department a computer program on baseball which will answer such questions as "Where did each team play July 7?"
- A 586 page U. S. translation of a Soviet study of rare earth spectroscopy (first published in 1953) is now available at \$7 from OTS, U. S. Department of Commerce, Washington 25, D. C. Ask for Report 61-31483. ✓✓✓ A report on U. S. exports of certain photographic products in the first half of 1961 is available as BD-61-155 from Information Office, BDSA, Department of Commerce, Washington 25, D. C. ✓✓✓ The office of Senator Hubert Humphrey, (D) Minn., Washington 25, D. C. has available comments on the "need for increased basic research in the Department of Defense." ✓✓✓ The Navy is interested in fuel metering equipment for aircraft which will be insensitive to fuel-borne dirt and ice. The equipment should have no moving pieces in contact with the fuel.
- The Atomic Energy Commission, Information Office, Washington 25, D. C. has available Announcement D-207 listing 56 research programs under the U. S. - Euratom Joint Research and Development Board in Brussels, Belgium. ✓✓✓ The Air Force estimates that some 1,500 miles of cable and 4,000 splice cases will be required at just one Minuteman ICBM base -- Ellsworth Air Force Base, South Dakota. ✓✓✓ The U. S. Bureau of Mines now says that the use of the silicone chemical "silane" to keep underground water from filtering into natural gas storage is "inadvisable". Technical details are in Report of Investigation No. 5836, Free from Publication-Distribution Section, U. S. Bureau of Mines, 4800 Forbes Avenue, Pittsburgh 13, Pa. ✓✓✓ The Information Office, U. S. Geological Survey, Washington 25, D. C. has available Release P.N. 98895-61 summarizing new findings on U. S. geothermal areas, where natural steam might be of value for power production.
- The Ohio State University Research Foundation has advised the Air Force that it will probably be feasible to construct a steerable antenna having a gain on the order of 70 db at 2000 mc for use in a West Ford passive communication system. A report (AD 255 977) is available at \$1.60 from OTS, U. S. Department of Commerce, Washington 25, D. C. ✓✓✓ The U. S. Bureau of Commercial Fisheries, Post Office Bldg., Gloucester, Mass. is looking for companies interested in mechanizing the blue crab industry. ✓✓✓ Springfield College, Mass. has completed a study for the Army on "The Effects of Sole Design and Composition Upon the Length of the Footprint Left During Walking." ✓✓✓ The Pentagon has received a technical report from Navy researchers at Bayonne, N. J. on "The Effect of the Use of Dehydrated Potato Granules on the Subsistence Operational Readiness of Naval Vessels." ✓✓✓ A summary of a Study of Auroral Fluctuations, which may contribute to more effective techniques of radio propagation, is available from the National Bureau of Standards, Office of Technical Information, Washington 25, D. C.

RESEARCH CHECKLIST

- ZIRCON PROCESS: Tests by the U. S. Bureau of Mines show that a commercial grade of zirconium diboride can be made directly from zircon without the costly and complicated intermediate steps generally considered necessary. Suggested uses include rockets and jet engines, as thermocouple protection tubes, as containers for molten metals in die casting, as flame-plated coatings on less refractory compositions to prevent erosion by hot gases, and as control rods and neutron shielding material in nuclear engineering. Bureau researchers also believe that the process may make possible new uses for the product, such as filters for hot gases.
- (Report Available. Single Copies Free. Write Publication-Distribution Section, U. S. Bureau of Mines, 4800 Forbes Avenue, Pittsburgh 13, Pa. for Report of Investigations No. 5770)
- ULTRASONIC NONBOND STUDIES: The Oak Ridge (Tenn.) National Laboratory of the Atomic Energy Commission has found that new ultrasonic techniques can provide a successful solution to what had seemed to be an "impossible" inspection problem -- involving small nonbond areas in clad structures. One such application was the nondestructive testing of the brazed bond between a stainless steel tube and a large annular copper cylinder. A large number of tiny thermocouple holes in the heavy copper section and the very small bore of the tube precluded the use of through-transmission or normal pulse reflection techniques. However, a small probe containing two transducers was custom-designed and fabricated to accomplish the necessary evaluation from inside the tube. The design of the probe required the presence of a nonbond area for a so-called Lamb wave to be generated and detected. Destructive testing on test samples indicated that the technique was capable of detecting nonbond conditions smaller than $1/8$ in. diameter.
- (Studies from Report TID-11295 (Suppl) available through AEC channels or at \$1.25 from OTS, U. S. Department of Commerce, Washington 25, D. C.)
- HEAD-MOUNTED CAMERA: The Federal Aviation Agency has made public details of a head-mounted camera for recording the eye movements of pilots. A 16 millimeter movie camera is used which weighs 4.5 pounds and is capable of recording 16 minutes of activity at 4 frames per second. The report now available describes work completed in March, 1959.
- (Report PB 171 506 available through FAA channels or at \$1 from OTS, U. S. Department of Commerce, Washington 25, D. C.)
- ADAPTIVE FLIGHT CONTROL SYSTEM: The National Aeronautics and Space Administration appears to look with favor upon an adaptive flight control system for possible use in high-performance aircraft and missiles. Such a system measures vehicle response to small-amplitude control-surface deflections produced by a sinusoidal test signal. Changes in response to this signal are related to environmental changes. The system is continuously altered to maintain this response equal to a preselected value. NASA studies indicate that this might greatly reduce required flight-test programs. A major advantage is that it requires only the addition of a signal generator and a logic circuit to a basic command-control system.
- (Report available. 61 Pages. Single Copies Free. Write National Aeronautics and Space Administration, ATTN: CODE BID, 1520 H Street, N. W., Washington 25, D. C. for NASA Technical Note D-909)

P U B L I C A T I O N C H E C K L I S T

- EXPLOSIBILITY, a study of the changes in explosibility of a mixture of coal dust and air due to the presence of varying amounts of a combustible gas, such as methane. (Write Publication-Distribution Section, U. S. Bureau of Mines, 4800 Forbes Avenue, Pittsburgh 13, Pa. for Report of Investigations No. 5815)
- SPACE PLASMA MEASUREMENTS, a report on two electrostatic analyzers developed by NASA for measuring the energy and density distribution of interplanetary gas. 42 Pages. Single Copies Free. (Write National Aeronautics and Space Administration, 1520 H Street, N. W., Washington 25, D. C., ATTN: CODE BID regarding NASA Technical Note D-1035)
- SCIENTIFIC RESOURCES, WASHINGTON, D.C. AREA, the first comprehensive directory of research and development in and about Washington, D. C. including industrial organizations, Government laboratories, colleges and universities, etc. 72 Pages. \$2. (Write Mr. G. Kennedy, Science Bureau, 1616 K Street, N. W., Washington 6, D. C.)
- METALLURGY OF HIGH STRENGTH STEELS, a brief report on work by Watertown Arsenal Laboratories on lower tempering temperatures for sheet materials used in rockets and missiles. 1 Page. (Report DMIC Memo 118 available free to Government agencies, their contractors, subcontractors and suppliers from Defense Metals Information Center, Battelle Memorial Institute, Columbus 1, Ohio)
- SOVIET SEMICONDUCTOR TRIODES AND DIODES, a U. S. translation of a Russian handbook containing both general and detailed data on transistors and semiconductor diodes, describing operating properties in particular. 450 Pages. \$6. (Write OTS, U. S. Department of Commerce, for Publication No. 61-31116)
- ARMY MANUALS, a price list of field manuals, technical manuals and other literature available for public sale relating to the Department of the Army. 13 Pages. Single Copies Free. (Write Superintendent of Documents, Government Printing Office, Washington 25, D. C. for Price List No. 19)
- NATIONAL BUREAU OF STANDARDS AND THE SPACE PROGRAM, a Congressional report on the need for more precise measurements in the space age, with particular reference to the National Bureau of Standards. 13 Pages. Single Copies Free. (Write Committee on Science and Astronautics, New House Office Building, Washington 25, D. C. for House Report No. 711)
- APPLICATIONS OF RADIOISOTOPES AND RADIATION IN THE LIFE SCIENCES, a transcript of statements, testimony and exhibits from hearings on this subject held in March, 1961. 511 Pages. (Write Mr. James T. Ramey, Joint Committee on Atomic Energy F-88, The Capitol, Washington 25, D. C. regarding Hearings -- "Applications of Radioisotopes and Radiation in the Life Sciences")
- IDENTICAL BIDS, a transcript of hearings before Congress on the problem of identical bids to the Federal Government, State Governments and other public agencies. 196 Pages. Single Copies Free. (Write Chairman, Committee on Government Operations, Subcommittee on Executive and Legislative Reorganization, U. S. House of Representatives, Washington 25, D. C. regarding Hearings-Identical Bids to Public Agencies)
- THE METRIC SYSTEM, a transcript of testimony, statements and exhibits regarding proposals for U. S. adoption of the metric system. 74 Pages. Single Copies Free. (Write Committee on Science and Astronautics, New House Office Building, Washington 25, D. C. regarding Metric System Hearings, No. 14)
- MINE RESCUE APPARATUS, a handbook on the design, construction and operation of self-contained breathing apparatus, gas masks and lifeline telephones approved by the U. S. Bureau of Mines. A 1961 Revision. 281 Pages. \$1.75. (Write Superintendent of Documents, Government Printing Office, Washington 25, D. C. regarding publication No. I 28.16/2:R 31)

